

Friction Stir Welding of Aluminum Armor

Status: Pending Transition

PROBLEM / OBJECTIVE

The Marine Corps is in low rate initial production of the Expeditionary Fighting Vehicle (EFV), originally designated the Advanced Amphibious Assault Vehicle (AAAV). This vehicle is constructed from high-strength aluminum alloy 2519-T87 armor. One of the manufacturing challenges for fabrication of this vehicle is the need for productive and cost-effective welding methods that also maximize ballistic performance. In 1998, General Dynamics Land Systems Inc. (GDLS) and Edison Welding Institute (EWI) demonstrated that friction stir welding (FSW) offered a number of advantages for welding 2519 material. Successful ballistic tests confirmed that friction stir welding produces welds that are stronger and more ductile than can be achieved with arc welding processes. This Navy ManTech project was initiated to further refine the FSW process for specific application to the EFV. The objectives of this project were to produce welds with greater strength and increased ballistic performance than can be achieved with arc welds and to reduce fabrication costs by reducing process cycle time and distortion.

ACCOMPLISHMENTS / PAYOFF

Process Improvement:

This project demonstrated that FSW has productivity, distortion, and ballistic performance advantages for fabrication of the EFV compared to gas metal arc welding (GMAW). Optimum welding procedures were developed, mechanical properties confirmed, and process control methods were developed to assure production quality is maintained. Production welding procedures were demonstrated on ballistic test panels and prototype components, and the technology was transferred to General Dynamics Land Systems. FSW is the first joining process to pass ballistic qualification on 2519 aluminum in a butt weld configuration. The corner joint test represented the first successful ballistic test for this configuration as well.

Implementation and Technology Transfer:

The NJC worked directly with General Dynamics Land Systems Division and the EFV Team to ensure that the FSW procedures developed meet design requirements and are compatible with production conditions. The technology developed under this project was transferred

Navy ManTech Program
Rev A (Sep05)



to GDLS through technical briefings, FSW machine specifications, tooling concepts and hands-on operator training on the FSW process. GDLS converted a large machine tool into a FSW machine in the Lima Army Tank Plant in Lima, Ohio that was used to train GDLS welding operators and for further process development. GDLS is preparing equipment specifications to procure two new production machines to fully implement FSW for production of the EFV and has contracted with EWI to develop production tooling concept drawings.

Expected Benefits:

- High productivity friction stir welding procedures were developed for 2519 aluminum armor. The improved procedures enabled the productivity to be increased by over 400% for 1.0-in. thick plates compared to the original 2-pass procedure.
- The low distortion of the FSW is another productivity advantage of the process.
- The 5 Year ROI is 25.8 to 1 with an expected savings of \$25.8M.

TIME LINE / MILESTONE

Start Date: July 1999
End Date: March 2002

FUNDING

ManTech Investment: \$1,000K

PARTICIPANTS

Edison Welding Institute (EWI)
General Dynamics Land Systems